Lecture 1: Powerpoint Slides, Intro to EES & REFPROP, & Syllabus

Systems & Balances:

Dimension: a measurable concept (e.g. mass, length, time...)

Unit: size of scale used to quantify a diminsion (ft, inch, m, ...)

→ There are 2 systems commonly used by engineers

SI: System International → used by most countries

→ Completely self consistent ∴ does not require unit conversions. No multiplication by 12 or 5280, etc. just 10

English: used by old U.S. engineers ⇐ Even the english don't use english units!! → inconvenient unit systems

As Engineers you should be able to use any system

In Back Cover of text

Dimension	SI Unit	Other Unit
length	m	ft, inch, mile
mass	kg	lbm, ton ← also used in refrigeration
time	s	min, hr
force	N	lbf
Energy	J	Btu ⇐ British Thermal unit 1 lbm of water from 39°F → 40°F

Important to note the difference

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In this class you will be given problems in all units.

#1 rule for units: Take the given information in all units & convert them to base SI: K, Pa, kg, J then solve the problem in SI. → No unit problems carrying through

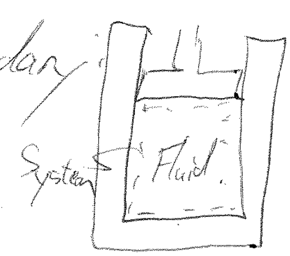
→ Then convert answer back to ~~all~~ desired units if needed

Once we have ~~the~~ something in consistent quantifiable units we can start to balance a system: what is being studied

Definitions:

System Boundary: Seperates system from surroundings. A system boundary can move depending on how it is defined.

Closed System: Mass cannot flow across system boundary.



Open system: Allows mass to flow across system boundary.
Your book calls these control volumes.

Isolated System: Does not allow mass or energy to flow across boundary.

Say:
- How do you select a system boundary?
Sometimes it's obvious, sometimes not ← just like statics
Take for example the piston cylinder, I could define the system to enclose only half of the ~~liq~~ fluid / bottom 50% → is this helpful? is this valid?
→ one pontentially frustrating part about thermo is that the laws are valid for __any__ system, but some system choices help you more than others.
→ It is important to have it clear in your own head what system you are considering → drawing helps this considerably

Questions to ask
1) have you drawn the system to account for the important factors?
2) Can you solve the system the way you have drawn it?
3) Is this the easiest way? | this will make sense later
now that we have a system, let's balance

Balance: IN + PRODUCED = OUT + DESTROYED + STORED

__Incremental Balance__: balances totals over a specified period of time
__Rate Balance__: balances rates at a specific instant in time

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→ Some quantities are easier to balance because they are conserved

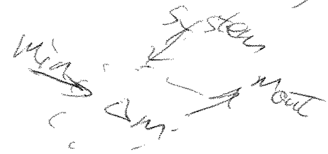
Money Balance: $\underbrace{\$_{in}}_{\text{What you are payed/bringing in}} + \underbrace{\$_{produced}}_{\text{? → hopefully not; Only if you are a mint}} = \underbrace{\$_{out}}_{\text{What you spend}} + \underbrace{\$_{Destroyed}}_{\text{? Destroying money is a federal offense}} + \underbrace{\$_{STORED}}_{\text{What you save}}$

At least on a personal level money is conserved: neither produced nor destroyed

So the balance becomes: $\$_{in} = \$_{out} + \$_{stored}$

Mass & energy are also conserved quantities: absent nuclear reactions (outside of course scope)

Increment mass balance $\underbrace{m_{in}}_{\text{mass flowed into system}} = \underbrace{m_{out}}_{\text{mass flowed out of system}} + \underbrace{\Delta m}_{\text{Change of mass in system}}$



Rate mass balance $\dot{m}_{in} = \dot{m}_{out} + \frac{dm}{dt}$ — rate change of system mass

signifies rate basis: kg/s

→ this is called the law of conservation of mass

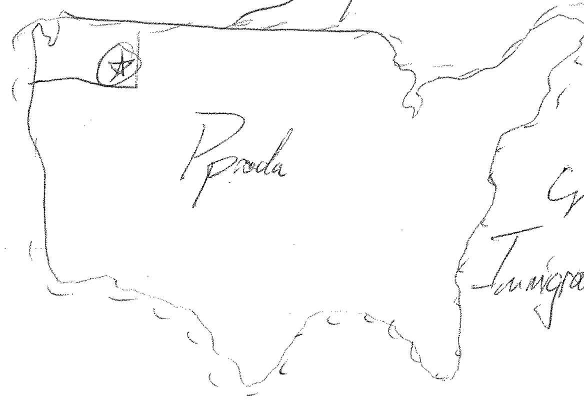
Finally, if a system is not changing with time, it is said to be steady or @ steady state.

IN = OUT + ~~STORED~~ → 0 = storage

Example: Is the U.S. @ steady state relative to people?

we'll do this on an incremental basis

System



Balance for 2010

$$\underbrace{P_{in}}_{\text{Immigration}} + \underbrace{P_{produced}}_{\text{Birth Rate}} = \underbrace{P_{out}}_{\text{Emigration}} + \underbrace{P_{destroyed}}_{\text{People pass away}} + \underbrace{\Delta P_{stored}}_{\text{Change in 2010 population}}$$

$P_{produced}$ = birth rate = $\frac{13.5 \text{ births}}{1000 \text{ people}}$ → Lowest ever since tracking began

$$\frac{13.5 \text{ people}}{1000 \text{ people}} \bigg| \frac{308{,}745{,}538 \text{ people}}{\text{in U.S.}} = 4.2 \text{ million people produced in U.S.}$$

$$P_{destroyed} = \text{death rate} = \frac{8.2 \text{ deaths}}{1000 \text{ people}} \bigg| \frac{308745538 \text{ people}}{\text{in U.S.}} = 2.5 \text{ million people}$$

P_{in} = best guess = 4.05 million people (including illegals), $P_{out} = 0.05$ million

$\Delta P_{stored} = 4.05$ million $+ 4.2$ million $- 0.05$ million $- 2.5$ million

$\Delta P_{stored} = 5.7$ million people → annual increase of 1.8%

U.S. is Not at steady state relative to people

We could've also done this on a rate basis

$$\dot{P}_{in} + \dot{P}_{produced} = \dot{P}_{out} + \dot{P}_{destroyed} + \frac{dP_{stored}}{dt}$$

Finished @ 8:40 → should expand on this next time